

# **Massachusetts GIS Strategic Plan**

## **Stakeholder Meetings & Information Gathering Sessions**

January, 2007

# What's this all about?

- Massachusetts is developing a **Strategic Plan** for future direction of GIS
- Focus of plan is **shared data needs**
- Plan needs to be **informed by GIS users** in Massachusetts
- Six meetings are being held to **directly solicit stakeholder input**
- **MassGIS** is part of the process; but this is **not** about a Strategic Plan for MassGIS, rather it's about addressing the needs of all GIS users

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First of all, thank you for giving us your time today.

MassGIS has initiated this planning process because we believe that there is a real community of interest around GIS as a technology. However, within that community, GIS development has occurred in a fragmented and disorganized fashion. We think this community has reached sufficient size in recent years – a “tipping point” if you will – that we should start looking at a more holistic and systematic approach. We're reaching out to the GIS community including not only direct users, but also others who may be managers or colleagues or otherwise involved with GIS-derived products.

The time seems right – a new administration, new possibilities, an opportune time to develop a strategic plan. But since we don't have a big budget, our planning effort has got to be something manageable, and so we're focusing on what is really at the center of our shared interest and that is data. Everyone who uses GIS needs a base of data, a platform to get started with. We refer to this as the “spatial data infrastructure for Massachusetts”. The focus of our plan is shared data needs – how do we make sure that all GIS users get that basic infrastructure to work with. Our plan, to be valid and useful, needs to be informed by all GIS users, from all sectors and levels of government and all parts of the state. So we want to hear from you. In order to really make sure that everyone is represented we've organized a steering committee, which is overseeing this effort and I'll get to the membership of that shortly. Just one more thing to make clear - MassGIS has been doing the logistics and planning for these events, and this kind of statewide coordination is part of our legislative mandate, but this is not all about MassGIS, rather it's about all GIS users and would-be users, your needs and opinions and insights.

# Project Overview

- **Goal** - To produce a [Strategic Plan for GIS](#)
- **Process:**
  - Information gathering workshops
  - Compile report
  - Review by Steering Committee
  - Approx. 25 in-depth interviews with major stakeholders
  - Draft plan, solicit comments, finalize
- **Funding:**
  - MassGIS received ‘supplemental’ Cooperative Assistance Program (CAP) grant from FGDC
  - Document will be consistent with [NSGIC/FGDC templates](#)
- **Coordination and Oversight:**
  - MassGIS administering project funding
  - Lead State agencies – EOT, MEMA, State Police, EOEA
  - AppGeo to draft plan and make recommendations

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So now that you know what we are trying to do, I want to give you a brief overview of the whole process and hopefully it will make sense. The end point is a strategic plan, but what will that plan do? We hope that this will help us make the case that the development of a sustainable statewide spatial data infrastructure is the right thing to do and that we will end up with some concrete suggestions of how to be more effective and productive with this exciting technology.

As some of you know we started last month with six workshops around the state. More than 200 people from many different public and private organizations attended these half-day events. We thought it was impressive that people were willing to give that much time to this process. In the second phase of this project, we'll compile the input that we got from the workshops and share it with professional organizations senior managers, and other key decision makers (and, yes, I'm talking about the folks with money) as we solicit more input. Hopefully we will validate what we learned from the workshops and be able to translate it into proposals for concrete action. After the interviews are complete, we will draft a written report with recommendations, including specific roles, timetables and financial commitments. We'll circulate that report for comment and then, finally, we'll be distributing this report in paper form, as a presentation, and via the web.

As I mentioned, we received some Federal funding, \$35k to be exact, for this project. The Federal government is funding this as part of a bigger effort, a nationwide effort, which means that we can take advantage of the work that other states have done. In fact we'll be using a template that was developed by the National organization of state GIS programs, a group called NSGIC. They suggested some of the questions that are on our agenda for today. But this is not something that we are doing just because the Feds are paying us to do it. This is very much about Massachusetts and doing what's right for our state and our users. The Federal template is something useful, and we will be filling in those parts of it that make sense for us.

Also, as I mentioned, MassGIS got the grant – but a number of other state agencies are also involved. In particular the lead agencies for the datasets that we are talking about – Transportation, Emergency Management, State Police. Finally, I want to say that we are fortunate to have a consultant, AppGeo, who has considerable experience in doing this kind of planning in other states. In fact they helped develop the strategic plan templates that we are using. AppGeo will be drafting the plan and working with us to finalize it and to make recommendations that are appropriate, reasonable, and well-founded.

# Strategic plan content

- Focus on four “categories” of data
  - Orthophotos and elevation
  - Road centerlines and address ranges
  - Parcels
  - Critical infrastructure
    - Facilities geocoded to building level
- Why these four?
  - They are important “framework layers” for all other GIS development and/or data layers that need to be widely shared between levels of government and public/private sector

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As I noted, since both money and time for the plan are limited, we are focusing on a few specific categories of data.

Imagery and elevation data are together because they are often, though not always, acquired together.

Ditto for road centerlines and address ranges associated with individual street blocks.

By parcels we mean parcels as shown on assessor tax maps, which exist for every municipality.

Critical infrastructure we will limit to actual buildings and facilities that can be mapped based on an address (“geocoded”).

We believe these are the important framework layers on which so much other GIS activity depends and that developing and sharing these is a very broad, very important goal.

So – we will be looking at how these are created and maintained, how they are used, what the needs are, and how the funding works.

# Agenda

Time	Topic
8:00-8:30	Registration and sign-in
8:30-8:55	Overview & Strategic Planning Context
8:55-9:05	Orthophoto Overview
9:05-9:30	Orthophoto feedback & discussion
9:30 – 9:45	B R E A K
9:45-10:05	Street Centerline and Geocoding Overview
10:05-10:30	Street Centerline/Geocoding feedback & discussion
10:30-10:45	Tax Parcel Overview
10:45-11:10	Tax Parcels feedback & discussion
11:10-11:25	B R E A K
11:25-11:40	Critical Infrastructure Overview
11:40-12:05	Critical Infrastructure feedback & discussion
12:05-12:25	Recap and wrap-up

# Strategic Plan Steering Committee

- **State Govt:**
  - MassGIS
  - EOEA
  - EOT
  - MEMA
  - State Police
  - DPH
  - DOR
- **Federal Govt:**
  - USGS
  - DHS/FEMA
- **Local Govt:**
  - City of Cambridge
  - Town of Spencer
  - Town of Westwood
- **Regional Govt:**
  - PVPC
  - MAPC
  - North Middlesex Registry of Deeds
- **Professional Organizations**
  - Assessors
  - Engineering and survey
  - Real estate
- **Academic**
  - UMASS Amherst
- **Other Private/Non-Profit**
  - Conservation groups
  - Utilities

Here's the organizations that are represented on the project steering committee, most of whom have taken the lead to be involved on behalf of a particular constituency. You can see that there are many different disciplines and levels of government - transportation, emergency management, public safety, public health, revenue, cities and towns, regional entities, professional organizations and academe. We feel that this is a pretty good cross section of GIS stakeholders.

# In the Audience

Based on RSVPs

- **State Agencies**
- **Regional Govt. (RPA, Registries, etc.)**
- **Cities and Towns**
- **Professional Groups**
- **Business and Non-Profit**

As we hoped, the organizational affiliation of those who attended the workshops was very broad. Most of the workshops had representatives from each of these sectors attending.

# Strategic Planning Context

- Take an overall look at GIS in Massachusetts
  - GIS **success stories** at all levels of government – what are the ingredients for success?
  - There remain some **challenges and gaps**
    - what are these and how do we overcome them?
- How does Massachusetts fit into the bigger picture - relevant Federal initiatives
  - National Spatial Data Infrastructure (NSDI)
  - Federal funds available to Fifty States initiative

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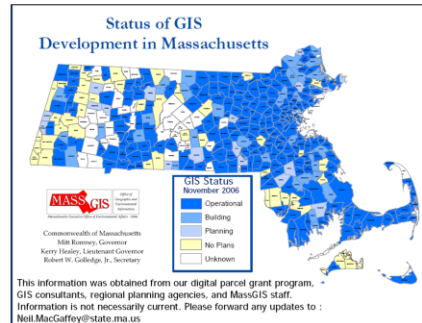
As a starting point, we're going to take a look at GIS in Mass overall. We think that where GIS is being used, its doing what its supposed to do – help people understand and solve problems, provide information, improve operations, optimize decisions. If you have GIS skills, you can get a good job. But GIS is not being used everywhere it could be, nor as effectively as it could be. There are some real challenges: overlapping responsibilities, redundant efforts, lack of communication, inadequate funding and so on. Part of what we are trying to do, and where we need your help, is in identifying both the successes and the challenges. We're looking at other states and using the guidance from the Feds to help us think about where we stand and where we could be going. We're starting by trying to place Massachusetts in the context of other states and in relation to two Federal initiatives. The first is something called the National Spatial Data Infrastructure or NSDI which we will describe further on. The second is a project known as the Fifty States Initiative, under NSDI, the effort to encourage all fifty states to undertake activities that support the development of the NSDI.



# Overview of GIS status

## GIS is widely deployed:

- **In state government...**
  - MassGIS since 1989
  - Many state agencies: EOT, DPH, MEMA, State Police, EOEA agencies, etc.
- **In regional organizations...**
  - At every RPA
  - Some Registries of Deeds
- **In local government...**
  - >150 cities and towns
- **In academia...**
  - Numerous academic programs in both public and private institutions
- **In private/not-for-profit sectors...**
  - Strong GIS consulting resources
  - Utilities, engineering and environmental organizations



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As I said, we see pretty wide usage of GIS in Mass. Many state agencies use GIS - I've listed only the major ones here. All the regional planning agencies use GIS as do many municipalities. GIS is present in academia and secondary schools, and of course a lot of companies in the private and non-profit sectors are heavy GIS users. Over 2000 organizations have, at some point, ordered GIS products from MassGIS. Our active mailing list of current users includes almost 1500 individuals.

# Where is Massachusetts?

- **Compared with other New England states**

- Extent of municipal adoption
- Parcel grants
- Public access to data, esp. on-line

- **Compared Nationally**

- We are comparatively data-rich, statewide
- Lack of county government presents challenges

- **In relation to the Federal Government**

- Need better coordination

Yes, we know where Massachusetts is on the map! But how do we stack up vs. other New England states – pretty well actually. The extent of municipal adoption is relatively high, although that use is nowhere near as effective as it could be. At MassGIS we've tried to support local GIS development through the parcel grants and by providing free CDs of data and on-line mapping tools. Looking at Massachusetts in comparison to states nationally, we are generally viewed as data rich. In terms of services that we provide though, we may not do as well. Our overall budget for GIS in all government agencies, adjusted for population, is just a fraction of what it is in some other states. The main point of difference is that we don't have county government, which means that we are mostly doing GIS data maintenance on a very local scale, which makes it a lot less efficient. In relation to the Federal government, we know we need better coordination, particularly of the various stovepipe relationships between federal and state agencies that results in a distressing number of redundant or overlapping projects.

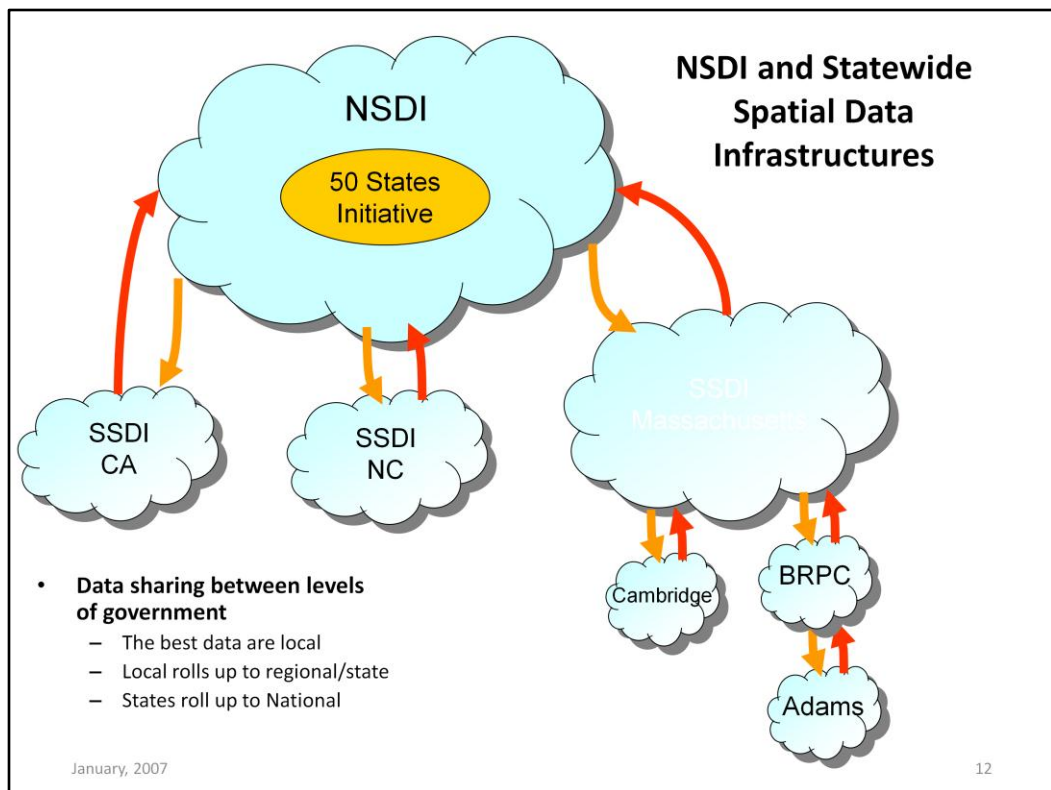
# Federal Initiatives

- **National Spatial Data Infrastructure (NSDI)**
  - Compilation and integration of data for 7 framework layers
  - 4 of the 7 framework layers are MA priorities for Strategic Plan
    - 1. Geodetic Control
    - 2. Cadastral (parcels)
    - 3. Political Boundaries
    - 4. Hydrography
    - 5. Imagery (orthos)
    - 6. Elevation (orthos)
    - 7. Transportation (Air, Roads, Inland Waterways, Rail, Transit)

Critical Infrastructure is not on FGDC list – why?

- **Geospatial One-Stop / National Map**
  - Portals for access to nationwide data
- **Homeland Security Infrastructure Program**

I mentioned before the national spatial data infrastructure or NSDI created by executive order (EO) of President Clinton in 1994. President Bush amended that order in 2003 to explicitly include outreach to state and local stakeholders. The EO requires federal agencies to provide “Technologies, policies, and people necessary to promote sharing of geospatial data”. Above are the seven framework data layers that comprise the NSDI – you’ll see that our first three data categories are part of this national framework. Our discussion of Critical infrastructure is really about making the connection between a whole list of other data sets, hundreds in fact, and the first three spatial categories – I’ll explain more about that later – so you can kind of consider it on the list as well. There are two other federal initiatives that we consider relevant – one is the portal to GIS information provided by the USGS with Geospatial One-Stop (GOS) and the National Map and the other is the Homeland Security Infrastructure Program (HSIP), which is now being redesigned but is essentially the Federally mandated framework for critical infrastructure layers.



This slide illustrates the multi-level approach which the Federal Government is endorsing with the NSDI. Within the NSDI, the Fifty States Initiative, which funded our strategic planning effort, is all about data sharing between levels of government. Everybody recognizes that the best data are local and they need to be rolled up to a regional or statewide and then a national level. Certainly part of what's driving this is the idea that when there's a big disaster somewhere, the surrounding towns or Mass Emergency Management Agency, or even federal agencies, have all got to be reading from the same playbook. But its also about just being efficient – why should the taxpayer who paid for local mapping also pay the state and federal governments to do the same mapping all over again?

## Criteria for Evaluating Statewide GIS Programs From 50 States Initiative

- 1. A full-time, **paid coordinator position is designated** and has the authority to implement the state's business and strategic plans
- 2. A clearly defined **authority exists for statewide coordination** of geospatial information technologies and data production
- 3. The statewide coordination office has a **formal relationship with the state's Chief Information Officer (CIO)**
- 4. **A champion** (politician, or executive decision-maker) is aware and involved in the process of geospatial coordination
- 5. **Responsibilities** for developing the National Spatial Data Infrastructure and a State **Clearinghouse are assigned**
- 6. The ability exists to **work and coordinate** with local governments, academia, and the private sector
- 7. **Sustainable funding** sources exist to meet project needs
- 8. GIS Coordinators have the authority to enter into contracts and become capable of **receiving and expending funds**.
- 9. The **Federal government works through** the statewide coordinating authority

Again, this whole strategic plan process is designed to help us understand how well we are doing – where we are successful, and where we need improvement... we'll quickly run through these criteria and then wrap up our overview and introduction to the project.

## How do we rate?

Criterion	Status
1. A full-time, <b>paid coordinator position</b> is designated and has the authority to implement the state's business and strategic plans	<b>PARTIALLY MEETS CRITERION</b> Paid director who is mandated to support coordination and has some authority but there is no executively mandated strategic plan in place.
2. A <b>clearly defined authority</b> exists for statewide coordination of geospatial information technologies and data production	<b>MEETS CRITERION</b> Legislative action identified MassGIS and MGIC as formal geospatial coordinating bodies for MA
3. The statewide coordination office has a <b>formal relationship with the state's Chief Information Office (CIO)</b>	<b>DOES NOT MEET CRITERION</b> MassGIS does not maintain a formal relationship with the CIO.  CIO has sign-off on all IT capital budget requests.

Massgis has legislative authority but there is no strategic plan in place. There is no formal relationship with the CIO.

## How do we rate?

Criterion	Status
4. A <b>champion</b> (politician, or executive decision-maker) is aware and involved in the process of geospatial coordination	<b>PARTIALLY MEETS CRITERION</b> GIS has had key political and executive champions at various times throughout its history, but there is not currently an active champion.
5. Responsibilities for developing the <b>National Spatial Data Infrastructure</b> and a State Clearinghouse are assigned	<b>DOES NOT MEET CRITERION</b> There is no formal responsibility for the NSDI. Mass. data are available through the National Map and we will soon have operational Clearinghouse node.
6. The ability exists to work and <b>coordinate with local governments</b> , academia, and the private sector	<b>MEETS CRITERION</b> There is strong, active coordination between stakeholders such as state agencies, local and regional government, academia and the private sector.

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There is currently no champion, although there has been in the past. There is no formally distributed responsibility for NSDI. Coordination is good.

## How do we rate?

Criterion	Status
7. <b>Sustainable funding</b> sources exist to meet project needs	<b>PARTIALLY MEETS CRITERION</b> There is some sustainable funding for core operations, but this covers a small % of annual expenditures. There is no sustainable funding for maintenance of key datasets.
8. GIS Coordinators have the <b>authority to enter into contracts</b> and become capable of receiving and expending funds.	<b>MEETS CRITERION</b> MassGIS has the authority to enter into contracts, and to receive and expend funds.
9. The <b>Federal government works through the statewide coordinating authority</b>	<b>DOES NOT MEET CRITERION</b> Numerous state agencies and programs work independently with the Federal government on geospatial matters.

### ■ Final Tally

- Meets criterion: 3
- Partially meets Criterion: 3
- Does NOT meet criterion: 3

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Only 42% of total expenditures could be classified as sustainable. the rest is soft money. There is a central coordinating group to manage GIS projects. Coordination with the Federal Government is poor.



## Next Section of Workshop: Data Layer Focus

- **Focus on 4 Key Data Categories:**
  - 1. Orthophotos and elevation data
  - 2. Street Centerline/Address
  - 3. Parcels
  - 4. Critical Infrastructure
- **Introduction covering:**
  - Current status
  - Future vision
  - Issues & opportunities
- **Interactive discussion –**  
**WE want to hear from YOU!**

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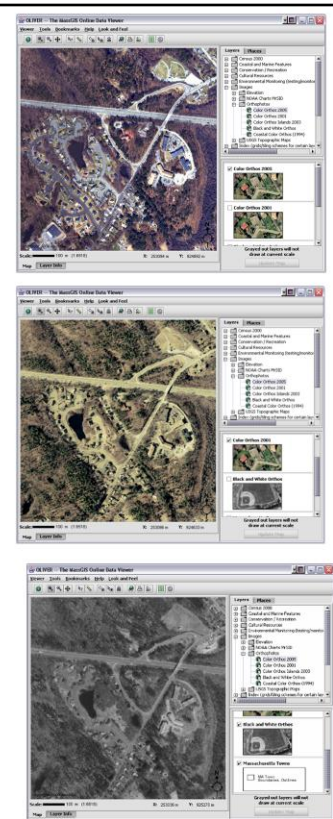
Well, we know we can't do it all, so we are going to focus on where we think we can add maximum value and that is in trying to make sure that every GIS user has access to the basic data infrastructure listed here. We're going into this with a very strong bias that sharing information is the right approach – again we don't think the taxpayer should ever have to pay twice for the same dataset to be built. But how and by whom these datasets get created and maintained is an open question and is a subject of the strategic planning exercise. For each of these data categories, I'll briefly discuss the current status, give some examples of applications, give you our version of the future vision, and lay out some of the challenges, issues, and opportunities. The main point of this is to hear from you about what we should be doing, is this the right vision, how do we make it work? Again, the reason we're here is to hear from you...

# Orthophotos

## Current Status:

- Statewide imagery program  
1/2 meter resolution (~20 in.)
- 3 years of statewide imagery
  - 2005: Digital camera 4 bands
  - 2001: Color film
  - 1994-1999: Black & white film
- DTM supports 3 meter contours

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As I'm sure you all know, we've had a statewide ortho program since about 1994 which has provided medium scale imagery, that is equivalent to 1 inch = 400 feet scale mapping, with an accuracy of plus or minus about ten feet and a pixel size of a half meter (~1.5 feet for those not familiar with meters). To fund these flights, we have put together a number of partnerships between local and state and federal government and other partners. For example, some of the early funding came from the USGS and NEES (an electric utility now called National Grid), the MWRA, the City of Cambridge, MassHighway, and the state's environmental agency. The most recent mission in 2005, which was \$865,000 dollars for the whole state was funded through a partnership between the state's Transportation agency, the Department of Public Health, and, again, our own agency, Environmental Affairs and its Department of Environmental Protection. So creative funding arrangements have been typical from beginning of this program.

The 2005 images were the first statewide mission to utilize a digital camera. By selecting this approach we were able to get four bands of reflectance in the images: that is red, green, blue, as well as infrared. Later I'll show you some of what you can do with the infrared band.

We've also developed and updated a statewide digital elevation dataset which supports ten foot contours. This is particularly valuable for watershed modeling, habitat characterization, generating viewsheds, 3D visualization, and so on.

# Orthophoto - Applications



Stereo Pairs

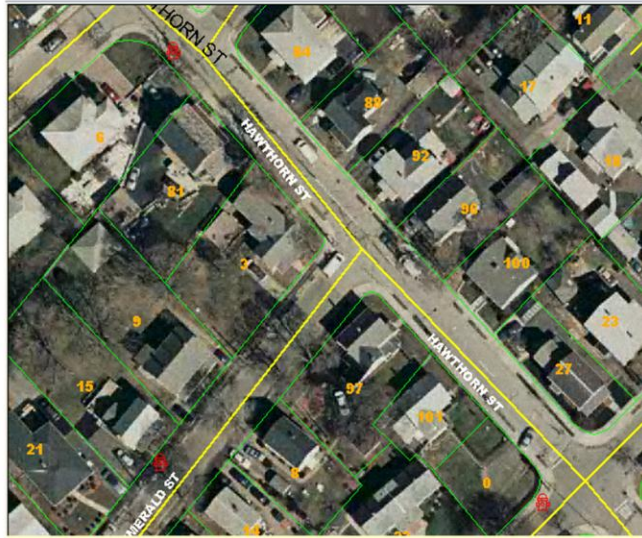
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So what do GIS users do with imagery—here are some examples to get started. but I want to hear your examples as well....

Even before orthophotos are made, the raw imagery, in the form of “stereo pairs” (images depicting overlapping areas) is used as a source for compiling map features such as building outlines, edge of pavement, manholes and catch basins, etc. - most of the GIS vector data created for cities and towns comes directly or indirectly from this kind of imagery, so we need to make sure we support that as we move forward in digital mode.

# Orthophoto - Applications



Ortho with roads, parcels, hydrants

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Just by itself the orthophoto is tremendously useful as a base map to provide context – the ortho gives you a familiar intuitive view of the world which is a great complement to vector mapping. This slide shows some vector data sets, parcels, streets, the red dots are fire hydrants, but the overlay of course could be any kind of data. We're seeing more and more use of orthos in real time by public safety or public works personnel in operational settings.

# Orthophoto - Applications

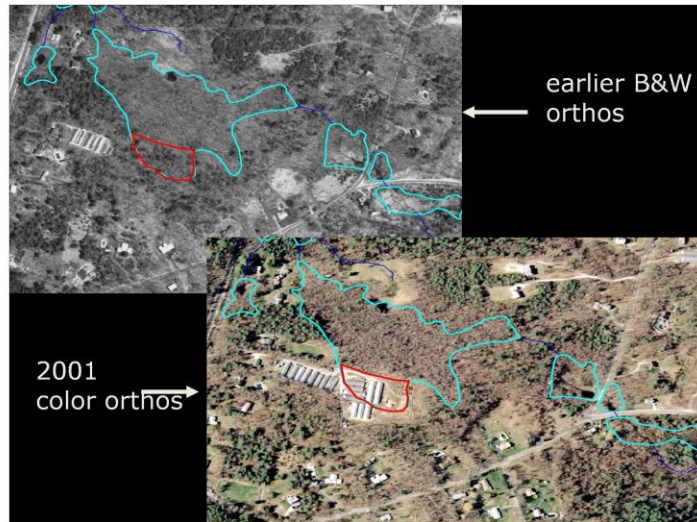
The screenshot shows a web browser window titled "Site Locator - Microsoft Internet Explorer provided by http://www.mass.gov". The main content area displays an aerial orthophoto of a suburban area. Below the map, there is a compass and instructions: "Use the compass to move the map in a compass direction. Click the map to re-center or input point." Below this, there are input fields for "Street" (1450 TRAPELO RD), "City" (Waltham), and "Zip" (02154), followed by a "Locate" button. To the right of the map, there are "Zoom Out" and "Zoom In" buttons. Below the "Locate" button, there is a "Type:" section with four radio button options: "Approximate location of point of Chapter 21E release", "Approximate center of individual tank or cluster of tanks (AST or UST)", "Approximate location of source of contamination", and "Approximate center of site or area of known contamination". Below this is an "Accuracy:" section with three radio button options: "Estimated horizontal accuracy is less than +/- 100 feet", "Estimated horizontal accuracy is less than +/- 500 feet", and "Estimated horizontal accuracy is less than +/- 1000 feet". At the bottom of the form, there are "RETURN TO PDF FORM" and "Quit" buttons. The text "eDEP Site Locator (v 10.28.03)" is visible in the top left corner of the application window.

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Another possibility is using imagery on-line for reporting locations – here DEP is using a web mapping application to capture locations for regulated entities like dry cleaners – we will see later that this type of interface is also being used to report critical infrastructure locations.

# Orthophoto - Applications



Change Detection - Wetlands

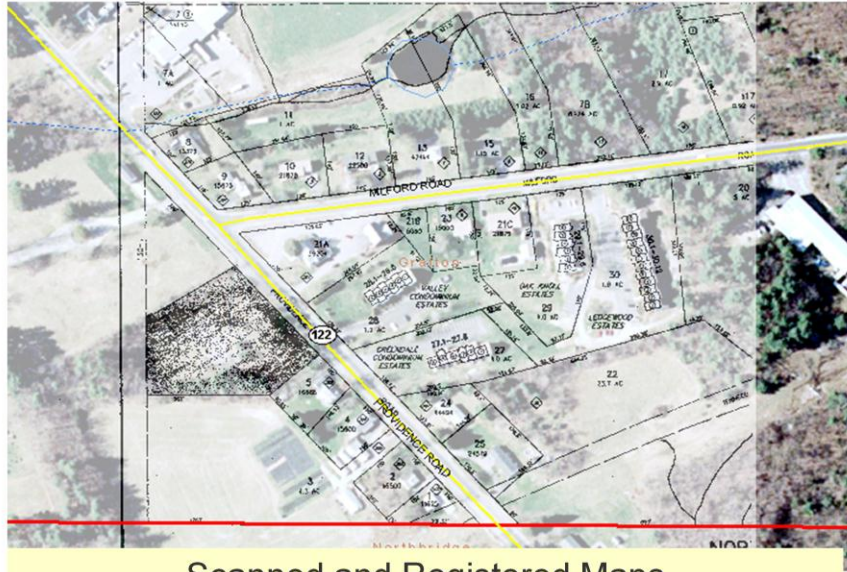
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The orthophotos have been used very effectively for change detection, here again by DEP. In this example, DEP is identifying wetlands violations and yes, that's an illegal fill and yes, it did lead to a serious enforcement action and a large fine.



# Orthophoto - Applications



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Another most important application for the orthophoto is as a base for georeferencing scanned documents and compiling parcel outlines. So what you see here is a transparent image of a scanned parcel map overlaid on the orthophoto. This is the basis for creating a version of the assessing parcel lines in a GIS database.

# Orthophoto - Applications



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Impervious surface from 4 band imagery

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This slide shows impervious surface mapping derived from the orthophoto – this now exists statewide – it's a very useful product for things like hydrological modeling for floodplain studies or estimating non-point source pollution.



# Orthophoto - Applications



## Land Use Update with 4 band Imagery

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Finally, we're using the recent imagery, again in four bands, to develop a new land use map for the Commonwealth. Mapping current land use map supports implementing smart growth policies, regional planning and economic development, transportation modeling, habitat characterization, and much more

# Orthophotos

## Future Vision:

- Regularly scheduled and funded re-flights
  - New digital multi-spectral imagery acquired **every 3 years**
  - Participate in USGS Imagery for the Nation program
- Improved orthophoto products
  - **Enhanced resolution**: 6 inch - 1 ft. resolution
  - Derivative products from image processing
    - Impervious surfaces
    - Land cover
- Improved elevation data and contours
  - Support **2 ft. – 5 ft. contours**
  - Potential for statewide LiDAR

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The vision for the orthophoto program is really just more of the same, only better. We'd like to have a statewide overflight every three years; but we need to hear from you if that is the right interval. We'd like to know where the funding is coming from - frankly we don't think its appropriate to rely on impromptu arrangements to fund a product whose usefulness is so widely recognized. What's more, if we get our strategic and business plans together, we will have a much better chance of partnering with the federal government through the proposed Imagery for the Nation Program, which might cover most or all of the cost.

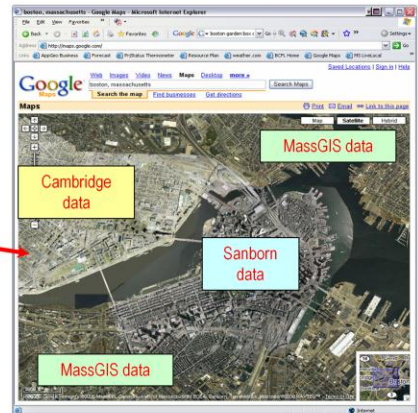
We've heard consistently that higher resolution is important – what is the sweet spot for most communities? is it six inch - would one foot be ok in less developed areas? We'd like to continue what we've been doing with digital 4-band imagery because we believe that the derivative products, the impervious surface and the land use/land cover mapping and other products that we haven't even imagined yet will be very valuable.

As long as we're visioning, we'd also hope to develop 2 foot contours for all urbanized areas – its worth noting that the price for a new technology for mapping topography ("Lidar") is coming down ...when we priced it statewide in 2003 it was over \$2million and now we believe that it might only be half that.

# Orthophotos

## Issues & Opportunities:

- Doesn't meet all local needs either for resolution or DTM
- Expense of imagery – cost sharing
- Integrating local data into statewide coverage
  - Mosaic a la Google
  - Better resolution
  - Currentness
  - Protection of local interests in data



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What are the issues – the challenges and the opportunities with the ortho program? Right now, the statewide product is a great resource for users GIS who don't need or can't afford higher resolution, but it doesn't meet local needs in built up areas where there's a lot of infrastructure.

The challenge is that imagery is expensive, and although we've been able to cobble together some partnerships at the state agency level, we haven't dealt with the challenge of cost-sharing between state and local level.

One development that has made the ortho highly visible is its use on the web, that's our statewide imagery you see in Google covering most of the Commonwealth with occasional areas, as you see here, featuring higher resolution or more recent local imagery... you see here Sanborn's imagery for Boston and the Cambridge orthophotos combined with imagery provided by MassGIS. So if Google can do it, why can't we? This is our vision -- to have the best available imagery accessible to all GIS users inside of GIS as well as on the web...

# Orthophotos: Discussion

- How is it or would it be used?
- What scale/accuracy/coverage is needed?
- How often do we need to fly?
- Who should pay?
- Can we aggregate local data?
- What role should the state play?
- Who should decide?

These are the questions we would like to answer in the discussion.

# Roads & Addresses

## Current Status

- **Statewide road centerlines exist**
  - Linework based on 1:5k orthophotos
  - EOT uses GIS data to manage “road inventory”
    - Extended attributes on road characteristics
    - “linear referencing system” to manage complex data
  - Updates from 3 sources
    - 2005 orthophotos
    - Navteq Conflation Project
      - New linework from commercial source (GPS-equipped vehicles)
    - Municipal submittals
      - Some communities do; some communities don’t
- **Statewide address range data exists**
  - State license of Navteq data provides address range data
  - Enables statewide geocoding

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Our current roads data was developed and is being maintained on top of the orthos. In fact we obtained road centerlines as an upgrade from the orthophoto elevation model break lines originally and the road centerlines can be readily interpreted from the ortho. That connection is why a lot of the funding for the ortho program has come from the state’s Transportation agency (EOT). As part of managing the statewide road inventory EOT links from the road centerlines in GIS to a lot of physical attributes - things like number of lanes, classification, pavement condition – and all this info goes into reports to the Federal Highway Admin.

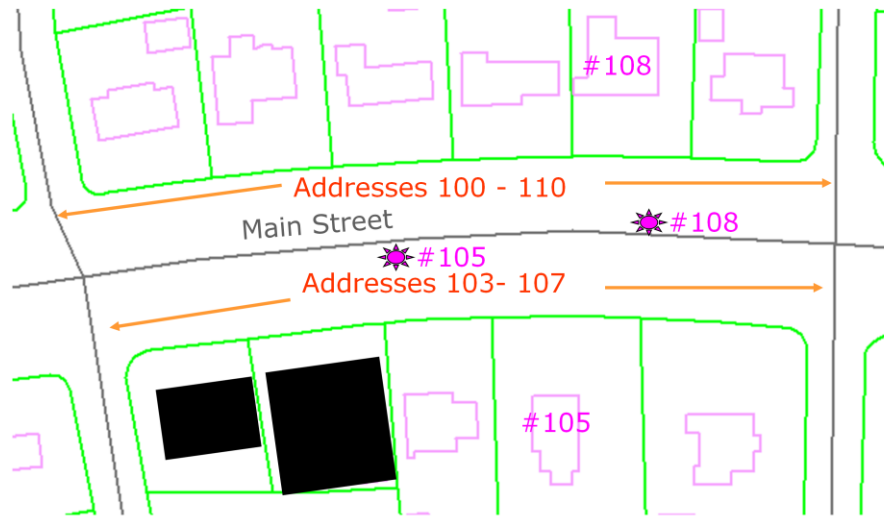
You’re all familiar with mile markers, those little signs that give you the distance along any given route from beginning to end. The system that EOT uses for tracking discrete sections of their roads is actually built on a very similar concept; it’s called linear referencing, but it’s just the GIS version of a mile marker. That means that any point location like a crash location, or any linear piece of road like a repaving project, is identified by its location or distance measured from the very beginning of the road. This kind of system is a very flexible and powerful way to manage data. I’ll come back to that shortly as part of our vision for the road centerlines. So what about maintenance? There are three ways this is happening. First, roads built before 2005 will appear in the orthophotos, so obviously lines representing new roads visible on the orthophotos can be captured that way, but then of course we wouldn’t have any attributes... The second source of maintenance input takes care of attributes as well, by tasking a commercial vendor of roads data - Navteq - to go out in the field, and find every new road, and to drive it with a GPS enabled truck so that they capture the geometry of the road. That means we don’t depend on the ortho. Also, Navteq is capturing the information like the addresses on the street, the name as it appears on the street sign and so on. So in effect we are field checking every new road – no more paper streets!!

What we mean by tasking Navteq is working with the official 911 list of streets, called the master street address guide, to find streets that are missing by name from their database. I mentioned that Navteq is a commercial product, which you have to license, but the good news is, as I hope you are all aware, EOT and the State E911 agency have licensed the Navteq data – that is the map of all streets in the Commonwealth with names and address ranges attached to them - for use by any government entities, state agencies, RPA’s, or cities and towns in the Commonwealth. This is what I call a win-win-win situation - we are all benefiting from this arrangement. E911 gets updated roads for 911 and emergency response. EOT gets a more complete inventory and we get to use the NAVTEQ data. I’ve mentioned compilation from ortho, and GPS data from Navteq. The third stream of road data updates is that towns are supposed to submit information on new accepted roads directly to EOT, unfortunately though only about 30% actually do it.

I mentioned address ranges, the point there is that having the Navteq data allows GIS users to do geocoding – I want to make sure that everyone knows what we mean by geocoding, so let’s take a brief look at that topic.

# What is Geocoding?

Creating a point on a map representing the location of a street address, for example: 105 Main Street or 108 Main Street



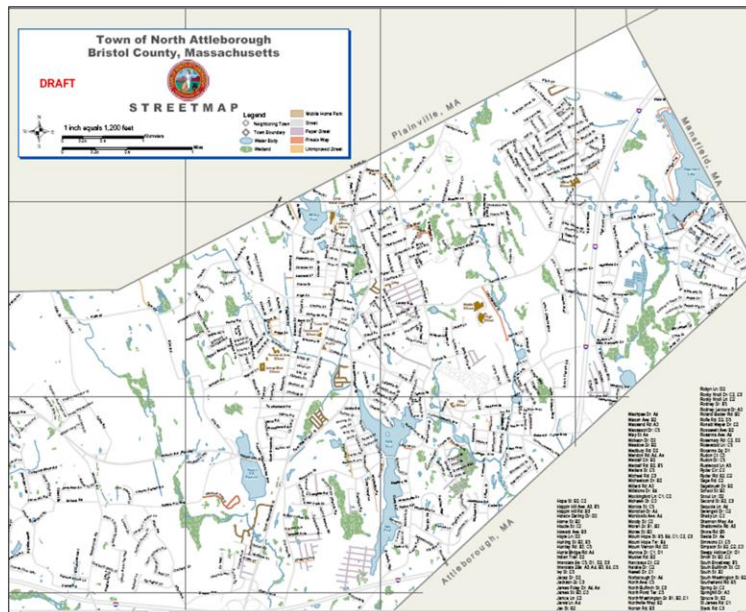
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Besides having a relatively complete and up-to-date street map, the big benefit of the Navteq data is that anyone can use GIS to do geocoding which means estimating a point location based on address - that's very useful for anyone who is planning service delivery, or who wants to look at the demographics of their client base, or at the most basic level anyone who just wants to put the approximate location of a facility on a map. But I want to stress the word approximate, because we've seen errors up to several hundred feet with linear geocoding.

Here's an illustration of how it works. You see here a street segment, a block on main street and you see that on the left and right sides you have two address ranges - 100 to 110 and 103-107. If you're trying to get to 108, and all you have is the road centerline with its address range, then you estimate the location of 108 accordingly. But as you can see on the bottom, that doesn't always work very well - number 105 estimated to be in the middle of the block winds up in front of the wrong house. Geocoding to the parcel level, if the parcel has an address, is necessarily going to be more accurate. beyond linear geocoding and polygon geocoding, there's geocoding to a point that is on the building, which isn't hard to do if you have current ortho and parcels except when you have a single parcel with many buildings, Then beyond that there's geocoding to the right entrance of the building or to the unit within the building.

# Roads & Addresses: Applications



Town Street Map

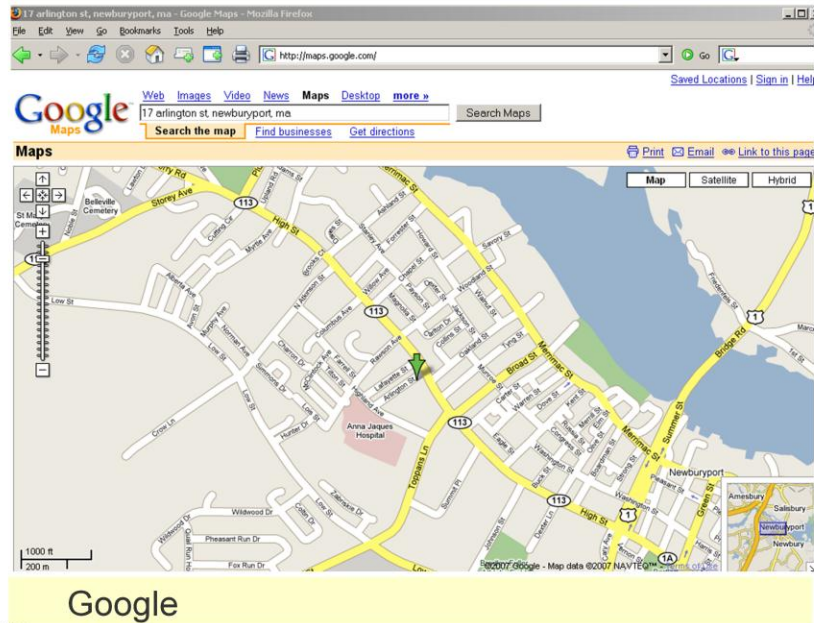
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What do we do with roads data –the most basic answer is that sometimes you need a map to get where you are going.



# Roads & Addresses: Applications



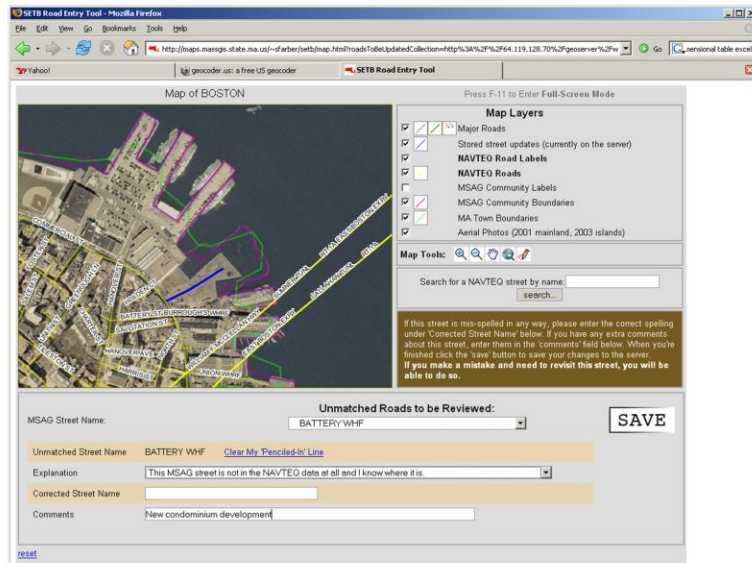
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More and more people are going to the Internet to get that road map - I'd say that the biggest GIS application by far is Google. Again, it's about getting directions from one place to another, using Geocoding to estimate address locations. When I mentioned that we are working with Navteq to improve the roads data, that's the same data which is used in Google. So we're helping Navteq deliver a more accurate map via Google – I wish they were paying us instead of the other way round.



# Roads & Addresses: Applications



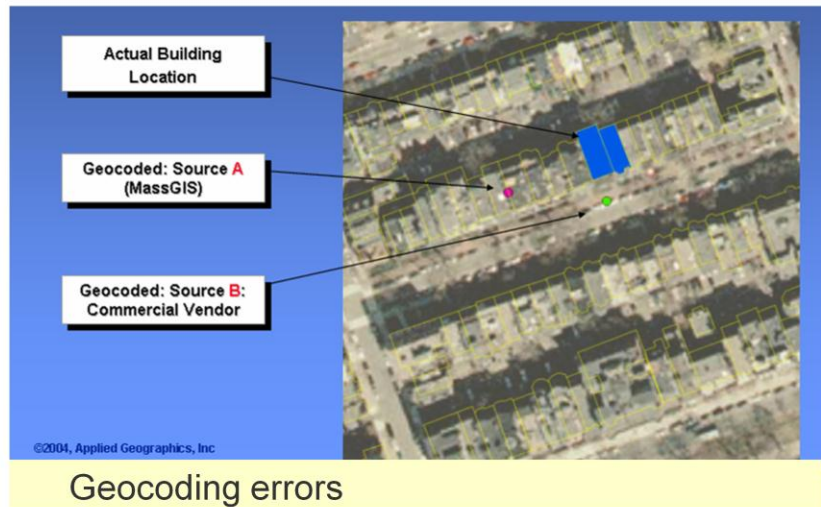
## 911 Application

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Heres an Internet based tool for entering a new street segment (IN BLUE) so Navteq has an approximate location that helps them go out and find the correct location and related attributes.

# Roads & Addresses: Applications

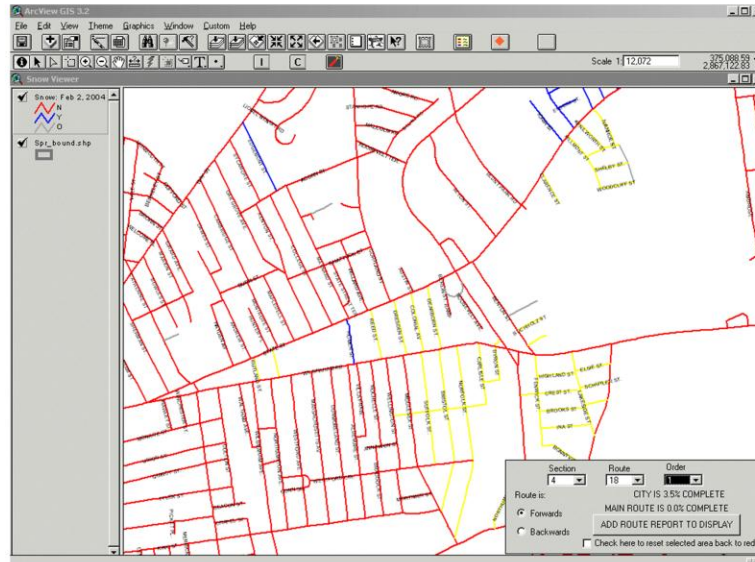


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As I mentioned there's a big "but" with Google and with geocoding - those of you who have used on-line mapping know that it could do a lot better estimating address locations, particularly in rural areas. we've seen errors up to 300 or 400' on average. if you're trying to evacuate a day care or a nursing home then you can't be knocking on doors to figure out which building they are in...

# Roads & Addresses: Applications



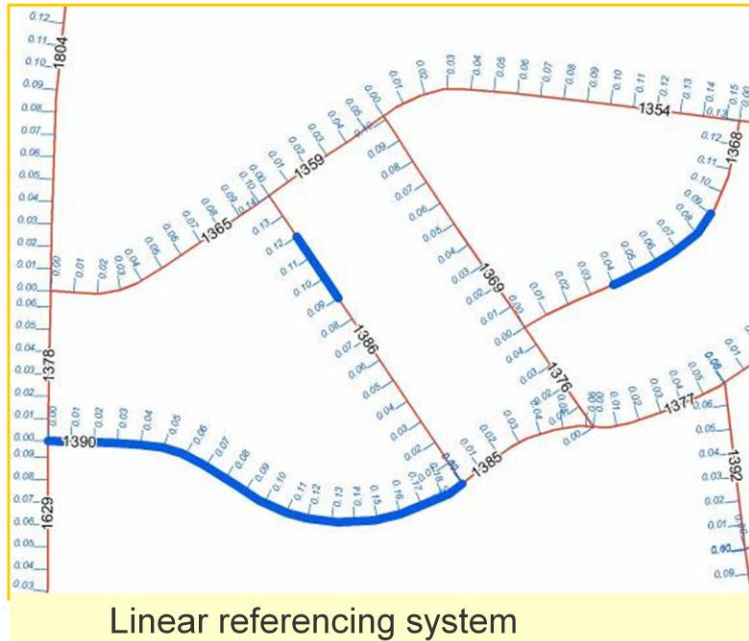
Asset Management eg Snow Removal

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Once you have road centerlines all kinds of options open up – this shows snow removal tracking for the City of Springfield.

# Roads & Addresses: Applications



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Typically such systems use linear referencing which is what you see here - where descriptive attributes like pavement condition are assigned to segments of road that are identified by their beginning and ending number in the linear referencing system. This is how the Executive Office of Transportation manages all their data using mile markers and sections along the roads.

[illegible]

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Finally, we see the Highway Department using GIS with very sophisticated asset management systems like this one which can display imagery and tell you about signage, pavement condition and a whole lot more – all based on your clicking a point location on the map...

# Roads & Addresses

## Future Vision

- **Road centerline improvements**
  - EOT scales up management of core linework
    - LRS can meet all stakeholder needs
    - Asset management needs similar
  - Updates flow “seamlessly” in from municipalities on a regular basis
  - Municipalities add their own details on top of core, shared geometry
    - Municipal attribute tables linked via EOT segID number or replicated LRS
- **Addressing improvements**
  - Move from “address ranges” to “address points”
    - Enabling improved location reliability
  - Leverage State Emergency Telecommunications Board (SETB) E911 file
  - Incorporate address locations from parcels

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Well of course where we would like to end up with roads and addresses is a perfectly current and accurate street centerline file for the whole state. Streets would magically appear in the data as soon as they were built, but not before.

In an ideal world, EOT would be getting data from the local level and incorporating it into the statewide file quickly and easily and then sending it out to the world. Municipalities could be using linear referencing systems for their own asset management programs, which would allow for much better communication between state and local public works departments.

On the geocoding front - addresses would go from being linear to being points so that geocoding applications would provide much more accurate locations. in our ideal world parcel data would be a source for address points – we’ve already seen this for a number of communities And even for entire RPA’s, as is the case with the Merrimack Valley Planning Commission.

# Roads & Addresses

## Issues & Opportunities

- **Requirement for complex 3-way coordination**
  - EOT manages core geometry, segment numbering & LRS
    - Standards to ensure consistency
  - Municipalities manage and submit updates on a regular basis
    - Communities that do not use GIS still benefit from submitting data
  - MassGIS and SETB are supporting the integration of 911 updates and address ranges from NAVTEQ
- **All parties benefit from access to rich, accurate and current road and address data**

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The challenge is that we have a lot of players – EOT has a very complex LRS system tied into a lot of responsibilities for Federal reporting, pavement management, signage, accident reporting and analysis and so on.

Town DPWs have their own similar missions and asset management requirements –again if they used the same basic road information as EOT that might make coordination of things like repaving projects a lot easier. but the challenge is that even though there is a clear financial incentive to share information because state funding is tied to their total mileage towns mostly don't provide updates of the local roads inventory to the state. Of course, some towns rarely see a new road...

Yet a third player in this data category is E911. At the state level the program is supporting the present effort to integrate a lot of updates into the roads file. Again as at the local level, there is both knowledge and incentive to provide updates to the state.

So the challenge is to put all that together ---

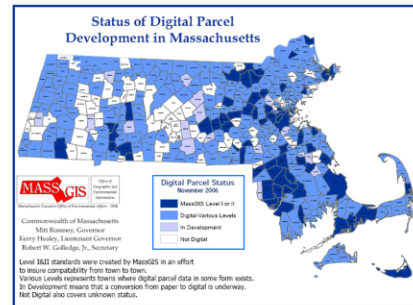
Still, maybe naively, we continue to believe that everyone can benefit from access to a single accurate and well maintained road centerline file with address ranges. So much of the information that we manage, as much as 80% by some estimates, is linked to an address. Mapping it is clearly an opportunity to better understand our clients and to improve service delivery.



# Parcels

## Current Status

- Parcel data are developed and managed at the local level
- Electronic parcel data exists for >150 communities
- MassGIS has issued digital parcel standards at three levels
  - Baseline spatial accuracy
  - Attribute consistency
  - >50 are MassGIS standards compliant at level II
  - Most were catalyzed via 2 rounds of “parcel grants” provided to communities



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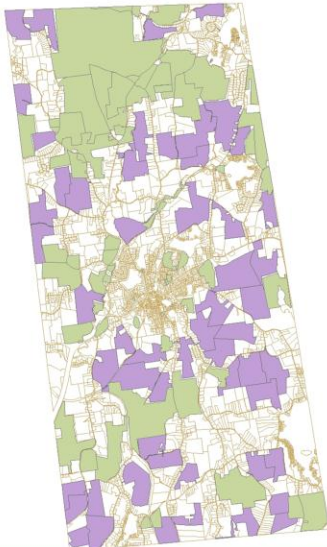
40

Parcel maps, assessor tax maps, as you all know, are managed at the local level. Even if a town doesn't have GIS, a lot of the tax parcel maps are being maintained by a third party in digital form. We estimate that there are over 150 towns with some form of digital parcels, although the quality of some of those is pretty poor. We've played a role in trying to standardize these files – the MassGIS parcel standard provides for spatial accuracy consistent with the orthophotos; it also provides a consistent way of solving the problems typically encountered by assessors in linking the GIS-based parcel map to the CAMA systems. What we're striving for is standardized parcel mapping in GIS statewide – at what we refer to as “Level 2” of the standard. About fifty towns are fully compliant with Level 2, at least they were when they received a parcel grant from our parent agency, the Executive Office of Environmental Affairs (EOEA) – although the grant only ensured one-time compliance and we can't be sure that the data are being maintained that way. However, we are encouraged that some communities are successfully using Level 2 of the standard as a specification for getting their parcel maps into GIS.

One big jump in 2006 was the automation and standardization of 15 towns worth of parcel data in the Southeast through our last round of parcel grants which targeted that region. Many of these towns came in through a funding partnership with the North Bristol Registry of Deeds and the intent is to link parcel data on line to scanned registry documents.



# Parcels: Applications



Open Space Plan



Abutters List

January, 2007

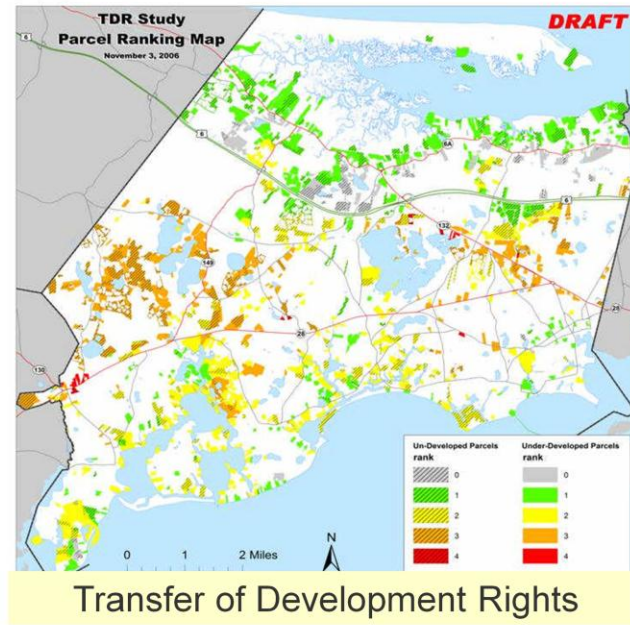
41

There are so many parcel related GIS applications that we can only touch on a few in pretty much random order.

One that's important for environmental organizations is identifying protected open space and targeting areas that need to be protected – this shows parcels over fifty acres in Spencer that were identified after Spencer's parcel map was brought into GIS and linked to assessing data.

Another real basic use shown here is generating abutter's lists which could take hours but using a GIS takes minutes.

# Parcels: Applications



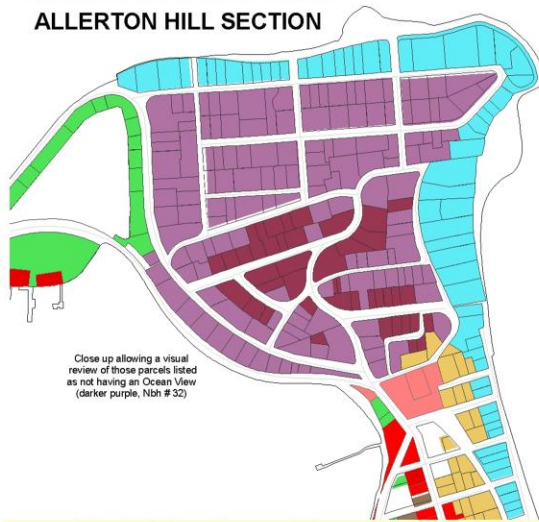
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Planners use parcel data to do analyses related to smart growth such as this study of the transfer of development rights in the Town of Barnstable.

# Parcels: Applications

## REAL ESTATE MARKET AREAS ALLERTON HILL SECTION



### Legend F 2007 RESIDENTIAL MARKET AREAS

- NEIGHBORHOODS**
- 7 WF SUNSET PT
  - 10 WF ALLER, ATL, GREEN HILLS
  - 11 WF-V BAYSIDE
  - 12 WF OCEANSIDE
  - 14 NEAR NAN BEACH
  - 15 WF BAYSIDE
  - 16 WF STRAWBERRY HILL
  - 18 WF BAYSIDE
  - 21 WF STRAITS POIN
  - 22 KENNERMA OCEANSIDE NO VIEW
  - 23 ALPHABET BAYSIDE NO VIEW
  - 24 ROCKAWAY & HILL NO VIEW
  - 31 KENNERMA BAYSIDE NO VIEW
  - 32 HULL, TELE, ALLER, STRAWHILLS NO VIEW
  - 33 WHITEHEAD SAGAMORE & ANNEX NO VIEW

- COMMERCIAL MARKET AREAS**
- NEIGHBORHOOD**
- 1 COM SUPERIOR
  - 2 COM EXCELLENT
  - 3 COM GOOD
  - 4 COM FAIR
  - 5 COM LOW

## Neighborhood Analysis for Valuation (Hull)

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The assessors themselves use GIS in all kinds of ways – such as this neighborhood analysis by the Town of Hull....showing that properties with ocean views need to be valued differently than those that don't...

**Legend**

1" Town Line	1" Roads to Meetings Only
2" Boundary	3" Rail Line
3" Municipal Line	4" Tax Boundary
4" Water	5" Change of Address
5" Easement	6" Road Closure

**The Town of Norton  
MASSACHUSETTS**

**Tax Map Checklist**

Scale: 1" = 100'

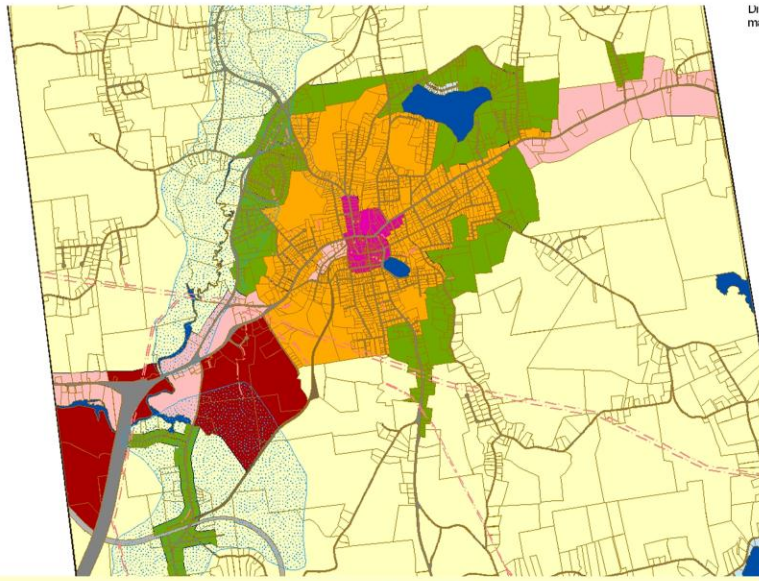
North Arrow

## Wetlands and Parcels

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Overlaying natural resource layers such as wetlands makes it possible to evaluate constraints on property that affect development value

# Parcels: Applications



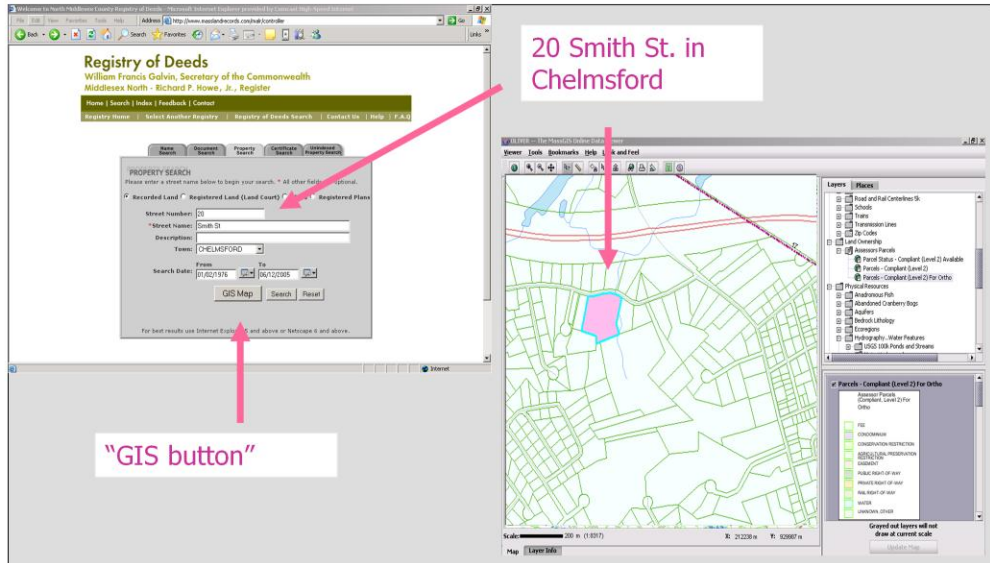
Zoning Aligned with Parcels

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Once parcel maps are in a GIS, they can be the base for adjusting zoning boundaries so that district boundaries align with assessors parcel lines.

## Parcels: Applications



“GIS button” proposed for Registry application

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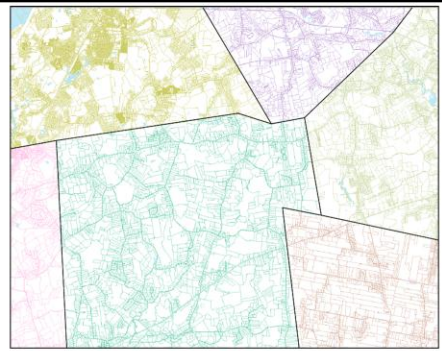
46

Finally, MassGIS is developing a prototype Internet-based tool with one of the Registries of Deeds that would enable standardized parcel maps and assessing data to be linked with deeds and other documents at the Registry.



# Parcels

## Future Vision



- **Statewide parcel layer is developed**
  - Use of standards makes this feasible
  - State funding helps “finish the job” for small communities
- **All communities maintain parcel data & share edits**
  - Technical assistance from RPAs or private sector
  - Automated replication
- **Statewide parcel data support a variety of applications**
  - Integration with official land records via Registries
  - Accurate mapping of any address
    - Critical infrastructure identification
  - Land use planning and smart growth
  - Conservation planning
  - Economic development – site-finder applications
  - Etc.

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This is the vision for the parcel data layer: all communities develop their parcel layer in accordance with the parcel standard and maintain it either in-house or with technical assistance from the regional planning agencies and/or the private sector.

Ideally the data would be shared and backed up at the state level. This will give us a database that is truly searchable and that can be linked to registry data as I mentioned earlier.

In this vision for parcel data, we have to ensure the quality of the data - for example, any data served up on-line should come from the local source rather than second hand. Replication of data between state and local level may be a way to do this.

The benefits of doing this are myriad – being able to use the data more readily and with more confidence, leveraging applications developed by other communities, I mentioned linking to the registries. Another huge benefit would be that GIS software could use the assessors maps and data to support mapping a location based on an address. Also, land use planning would be greatly facilitated, as would economic development.

# Parcels

## Issues & Opportunities

- 3 levels of government are involved:
  - **Local** government as tax parcel mapping managers
  - **Regional** Registries as official land record repositories
  - **State** government
    - DOR has mandate to certify local tax assessments
    - MassGIS has provided technical resources & funding
- Preserve the distinction between:
  - **Legal property boundaries** (based on deeds and surveys)
  - **Assessor's tax parcel mapping** (approximate)
- Understanding **local interests** in managing and distributing their parcel data
  - How to support the local role
  - Make data available to all levels of government
  - Address concerns about distribution, web access, currentness etc.

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There are lots of players – there are in fact three levels of government involved as well as the private sector.

Local government has the primary responsibility for maintaining the tax maps. However, the life story of a parcel begins with regional government, as in a legal sense, a parcel is created at the registry when a subdivision plan is recorded. So the communication between registries and assessors is very important. The role of state government is less well defined, but there are definitely technical resources and economies of scale that don't exist at either the local or regional level. There is also the authority to review and certify the local tax lists at DOR.

As use of parcel data expands, we also need to remember the distinction between boundaries in a legal sense and tax mapping. That's important because even with the best effort to compile the information on an orthophoto base map, in accordance with the MassGIS standard, the assessor parcel map lines are still not the legal depiction; property boundaries are something that only a surveyor can provide. So, in this context, disclaimers and proper use of the data are important.

We also need to be sensitive to local concerns about sharing parcel data. It's a public record and there is no option but to make it available, but how we do that and how we ensure the information is current and how we ensure proper use of the information is still an issue. Putting assessing data on the web raises concerns about privacy and so on that need to be addressed. MassGIS' policy, for example, is that we don't include owner names in parcel data we have put on-line. At the local level, some communities have a similar policy and others only exclude certain individuals, such as law enforcement officers.



# Critical Infrastructure

## Current Status

- Continued effort at Federal level to define critical infrastructure
  - HSIP vs. NADB vs. others
  - States have their own lists
  - “Most essential datasets”
- MassGIS has published several layers:
  - Schools, Hospitals, Prisons, Airports/Seaports, Utility territories
- MEMA has worked with other groups on HSIP layers:
  - DPH: nursing & rest homes, boards of health
  - EOT: ferries, parking lots, regional transit
  - HS regions: police and fire stations, town halls



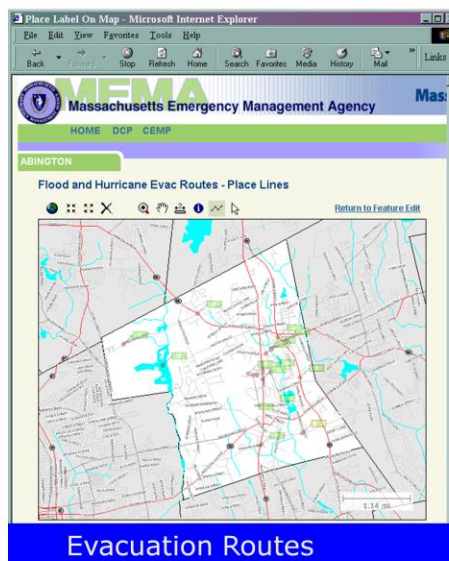
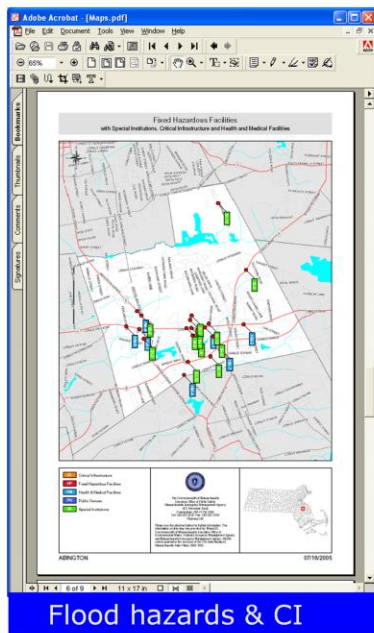
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Since September 11, 2001, it seems lists of “critical infrastructure” have been flying around, the top 200, the top 10, Federally designated, minimum essential data sets and more detailed so-called urban level data sets. A lot of data development has been supported by the Federal government, including data developed in our own regional Boston pilot. Many layers have been completed: statewide layers which represent sensitive populations, or critical infrastructure, such as schools, hospitals, prisons, fire and police stations, town halls and so on. These are really multipurpose data sets.

MEMA’s Electronic Comprehensive Emergency Management Plan (eCEMP), is a good example of a program to collect data with local knowledge, which is really the most cost-effective approach – data like police and fire stations, town halls need to be maintained at a local level. Besides eCEMP there have been some other programs funding data development on a regional basis like pre-disaster mitigation and all-hazards planning.

# Critical Infrastructure: Applications

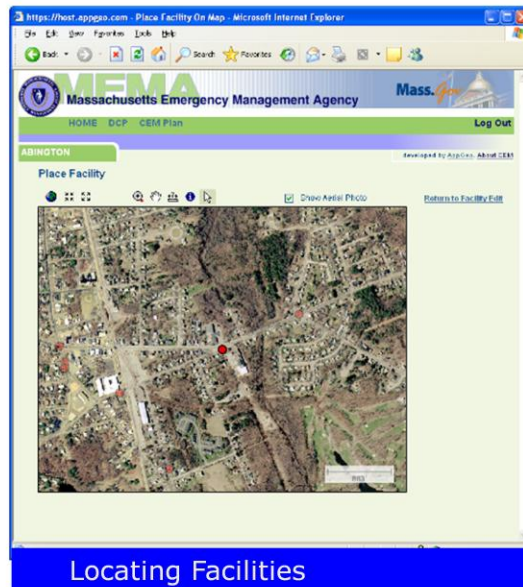


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Different categories of critical infrastructure facilities, in the graphic on the left we're showing proximity to flood-prone areas. On the right, we're showing evacuation routes. Of course it's important to plan these routes on a regional level as it makes no sense to simply have each community's plan being to evacuate into the adjacent communities!

# Critical Infrastructure: Applications

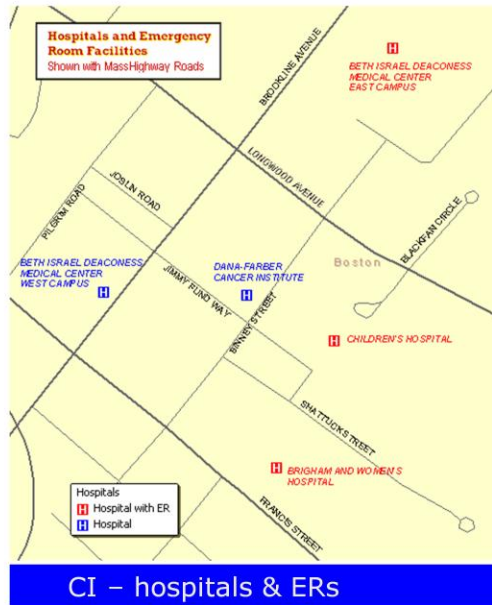


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Here we are showing how the Massachusetts Emergency Management Agency is using an Internet-based mapping tool to enable local public safety officials to correctly locate certain kinds of infrastructure features. Note that without the orthophoto basemap, this application would not be very useful.

# Critical Infrastructure: Applications

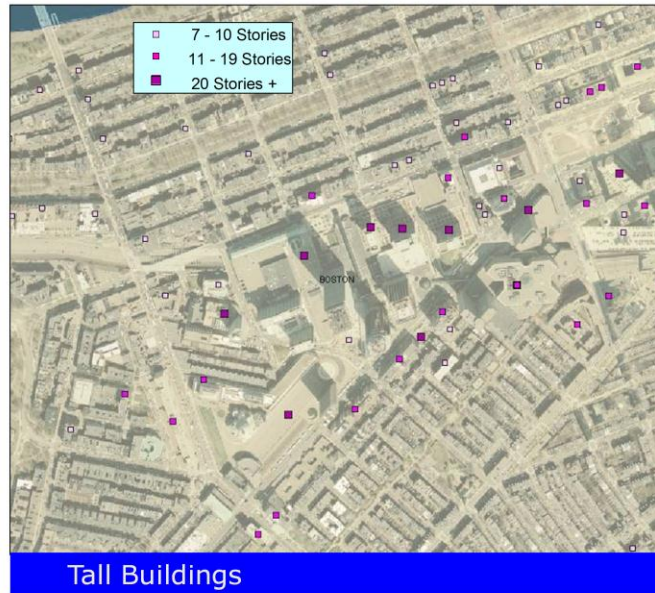


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As we noted at the beginning, many facilities of interest to emergency responders are associated with an address and GIS software can be used to geocode the locations of these facilities – in this case hospitals. That geocoding provides the starting point for a more accurate location of the point by someone with local knowledge.

# Critical Infrastructure: Applications



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For emergency responders in our larger cities it is not sufficient to simply have a dot on the map representing the facility. Here we show tall buildings in Boston which have been separately identified because for each building there is additional information that first responders need to know: how many stories, what are all the exits, how many elevators, diagrams of floor layouts and information about the building's emergency systems, etc.

# Critical Infrastructure: Applications



Plume Modeling

January, 2007

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And finally, we're showing here a more "high-end" sort of capability, which is that emergency response in dense urban areas includes the capability to model airborne plumes of toxic chemicals. This modeling is essential for being able to respond, knowing for example when it's safe to go back into an area. It requires more complex data sets such as these 3D models of buildings in Boston. These models were, interestingly, a by-product of detailed elevation data captured using the Lidar technology mentioned earlier in this presentation.

# Critical Infrastructure

## Future Vision

- Comprehensive, high accuracy statewide data sets can continue to be developed and maintained through e-Cemp or other means
  - To the “building footprint” level
  - Public safety and other uses are complementary
- GIS is a means of effectively sharing data between emergency responders
  - Local
  - State
  - Federal
- As much data as possible will be published, but not all

So the vision for spatial data in emergency response, whether in a police station, at MEMA, or in a vehicle, is no different from that for the radios: we want the radios from different emergency responders to work together; let's get the data sets working together also!



# Critical Infrastructure

## Issues & Opportunities

- Redundant efforts are minimized/eliminated
  - Current efforts are redundant due to overlapping federal programs
    - Homeland Security
    - Centers for Disease Control
    - eCEMP
    - RPA pre-disaster mitigation
  - Creation of an effective authority to coordinate data development
    - Do it once, do it right (standards)
    - Share the results
- Need to address requirements for non-public **secure access** and privacy protections
  - Some of these data cannot be published

In our vision, redundant efforts are minimized – the challenge is finding the political will to do that. The way programs are set up currently does not encourage applying one set of standards to data collected under different programs. We need effective state authority to do the right thing. We also need to have one single unified approach to what is secure and what is not. Over-restricting data access can be very counterproductive. In many cases, the approach is to classify some attributes as sensitive and for official use only, with others remaining in the public domain.